Morphology and Sedimentology of Panther Creek, Montgomery County Preserve

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Location
Sites along Panther Creek where it merges with Spring Creek in the Montgomery County Preserve, south of The Woodlands, Texas provide an excellent location to view numerous features of a meandering stream system.

Directions – Off of Interstate 45 take the Rayford/Sawdust exit. Turn West onto Sawdust. Turn South onto Budde Road. Go straight on Budde Road which will turn into Pruitt Road. Keep on Pruitt Road and turn left at the Montgomery County Preserve entrance sign located at 1118 Pruitt Road and park in the parking area on the right.
Setting

Panther Creek comes out of Lake Woodlands five miles to the north. The water that flows into the stream is the less muddy, cleaner upper part of the water column in the lake that comes over the dam spillway. This leads to the water flowing through Panther Creek to be clearer enabling us to see through the water and investigate features on the bed of the stream.

From Lake Woodlands, the stream runs through golf courses and by subdivisions where its course has been modified. However in the Montgomery County Preserve the stream has undergone very little alteration allowing natural processes to modify the landscape into what can be seen today.

Plan on getting wet if you would like to investigate all the features of Panther Creek, as the best way to see everything that is happening is to go into the stream itself and observe the active processes that are at work and the resultant deposits that are left behind.

There are three stops that will allow for investigation of different features of Panther Creek.

*Location of stops along Panther Creek covered in this guide and the paths to access them.*
Stream Morphology

Most of us speak of rivers, but geoscientists tend to call everything a stream. A **stream** is any body of running water that occupies a channel: it can even be underground in a cave or underneath a glacier. A **river** is a large surface stream, but other than that there isn’t a clear boundary between a stream and a river. Streams smaller than rivers, roughly in order of size, may be called branches or forks, bayous, creeks, brooks, coulées, runnels and rivulets. The very smallest kind of stream, just a trickle, is a rill.

**Features Associated with Meandering Streams**

A meandering stream migrates laterally by sediment erosion on the outside of the meander and deposition on the inside. Adjacent to the channel, levee deposits build up, and gradually raise up the river over the floodplain (mainly fine sediments). If the climate is humid the floodplain area beyond the levees may be covered with water most of the time, and may form a swamp. Meanders may cut into each other as they grow (neck cutoffs), and then the river shortcuts (growing meanders reduce the slope, cutoffs are a means to increase the slope again) and the old meander is abandoned and slowly fills with fine sediment during floods (oxbow lakes). As a river builds up its levees and raises itself over the floodplain, the slope and the transport power of the stream decrease, the channel fills gradually with sediment, and finally (often during a flood) the river will breach its levee (this process is called avulsion) and follow a steeper path down the valley.
The morphology of a stream (its shape, dimensions and other characteristics) are influenced by the slope it is going over, the speed (velocity) of the current, the volume of water (discharge), and the size of the sediment it is moving. Streams may be permanent or intermittent—occurring only part of the time. The most important part of a stream is its channel or streambed, the natural passage or depression in the ground that holds the water. The channel is always there even if no water is running in it. The deepest part of the channel, the route taken by the last (or first) bit of water, is called the thalweg (TALL-vegg, from the German for "valley way"). The sides of the channel, along the edges of the stream, are its banks. A stream channel has a right bank and a left bank: you tell which is which by looking downstream.

Riffles are areas where the water is flowing faster over shallow parts of the stream. Pools are areas of slower water where the stream is deeper. Runs are the sections of the stream between the pools and riffles where the current is smooth.
Under normal conditions, usually the water in a stream does not completely fill the channel up to the top of the banks on the side of the stream. After a heavy rain and there is extra water runoff the stream can fill up the whole channel to what is called the **bankfull stage**. If the water rises higher and overflows it banks it goes into **flood stage** and spills over onto the flood plain.

Stream channels have different **channel patterns**, the shapes they show when viewed from above or on a map. The curviness of a channel is measured by its **sinuosity**, which is the ratio between the length of the thalweg and the distance downstream along the stream valley between two points along the stream. **Straight channels** are linear or nearly so, with a sinuosity of nearly 1. **Sinuous channels** curve back and forth. Meandering channels curve very strongly, with a sinuosity of 1.5 or more. **Braided channels** split and rejoin, like the braids in hair or a rope.
The loops and curves of a slow-moving stream are called **meanders**. Meanders are formed by erosion and occur where a stream has worn away its banks. Most erosion normally occurs on the outside bend of a meander called a **cutbank**. This is because the velocity (speed) of the stream is faster. As well as the water hitting the banks, pieces of sediment may also be thrown against the stream banks wearing them away. Meandering stream channels are **asymmetrical**. The deepest part of the channel is on the outside of each bend. The water flows faster in these deeper sections and erodes material from the stream bank. The water flows more slowly in the shallow areas near the inside of each bend. The slower water can’t carry as much sediment and deposits its load on a series of **point bars**. Meandering streams erode sediment from the outer curve of each meander bend and deposit it on an inner curve further downstream. This causes individual meanders to grow larger over time.

Streams need energy to transport material. Normally, a stream has the energy to carry some sediment. When energy levels are very high due to a fast current and a lot of water (**velocity** and **discharge**), large rocks and boulders can be transported. When energy levels are low when the stream is slow with little water, only small particles can be transported. The **velocity** (speed) of a stream is not the same along its length or across its width. The thalweg of the channel contains the fastest current with the highest velocities. Lower velocities occur toward the banks of the stream. This allows the stream to erode sediment in one part of the stream and deposit it in another.
Deposition is where a river lays down or drops the sediment or material that it is carrying. Streams carry lots of different sediment or grains, including rocks, pebbles, sand, silt, and mud. These grains move along the stream in different ways depending on their size and the velocity of the current. The smallest sized grains (muds and silts) will be suspended in the water and not touch the stream bed. Bigger grains (sands, gravel, pebbles) are too heavy and they bounce, slide and roll along the stream bed.

Movement of sediment in a stream –
1. Fine-grained particles in suspension (suspended load)
2. Coarse-grained particles by traction (rolling, sliding, saltation or bouncing) along the streambed (bed load)
Point bars are the most common deposit formed in meandering streams, but other types of bars can also be deposited. **Lateral bars**, **mid-channel bars**, and **delta bars** (seen at Stop 1) can be found.

**Sedimentary Structures**

In the deposits of a stream, smaller scale features can be seen. As the stream erodes sediment in one area (like the cutbank) it will deposit that sediment in **layers** in other areas building up point bars and other features. These layers can be seen due to the different grain sizes and material found in each layer.
When a current flows over the bottom of the creek and moves grains along it, the larger size grains move along the stream bed in different ways (rolling, bouncing, sliding) and at different speeds and can form ripples.

A ripple generated from a uni-directional current (a current always going in one direction) has pointed crests and rounded troughs, and are inclined more strongly in the direction of the current with a gentle up-current slope (stoss surface) and a steeper down-current slope or slip face (lee surface). When the deposits from ripples stack on top of each other in layers composed of different angles of the lee surface of the ripples, this is called crossbedding.

In most present-day streams, ripples will not form in sediment larger than coarse sand. Therefore, the stream beds of sand-bed streams are dominated by current ripples, while gravel-bed streams do not contain bedforms. The internal structure of ripples is a base of fine sand with coarse grains deposited on top since the size distribution of sand grains correlates to the size of the ripples. This
occurs because the fine grains continue to move while the coarse grains accumulate and provide a protective barrier.

In the layers of a bar deposit you will mostly find only the lee side of the ripple. This is because the current of the stream will erode the stoss side of the ripple and deposit on the lee side as the ripple migrates downstream, only leaving part of the lee side behind.

*Layers of the lee side of ripples seen in the outcrop at Stop 2 resulting in crossbedding.*
Stop 1 – Confluence of Panther Creek and Spring Creek

**Directions** – From the parking area walk down the road toward the creek and go past the metal gate and along the gravel road. Where the gravel road makes a bend to the right there is a marker on the left of the road for the Spring Creek Overlook path. Walk along the path until you get to Spring Creek. At the creek continue along the path upstream to where Panther Creek enters Spring Creek.

Stop 1 is where Panther Creek merges with Spring Creek. Here the clearer water coming from Panther Creek mixes with the muddier water of Spring Creek. The difference in the amount of sediment in the water coming down the two creeks causes the water in these creeks to have different densities. Where these different density waters meet, there are small swirling patterns (eddies) on the surface of the water along a line where the clearer, less sediment laden, lower density water from Panther Creek mixes with the muddier, more sediment laden, higher density water of Spring Creek. A similar occurrence is happening in Costa Rica along the Rio Sucio where a sediment laden creek (as a result of mining runoff upstream) merges with the main flow.

![Image of the confluence of the clearer waters of Panther Creek and the muddier waters of Spring Creek from Google Earth. Notice that the creeks are at bankful stage in this image.](image-url)
Where the smaller Panther Creek flows in the larger Spring Creek, a **delta bar** can typically be found as sediment in the faster flowing Panther Creek falls out of the water column when it encounters the slower moving waters of Spring Creek. Different lobes of the delta bar can be seen on the below satellite image. Notice how the delta bar is elongated in the downstream direction. Because of subsequent flooding events and the variable flow of the creeks, these delta bars are deposited, eroded and modified on a frequent basis.
Pictures taken twelve days apart show the advance (progradation) of a delta bar out of Panther Creek and into Spring Creek.

Notice how the prograding delta bar is elongated in a down current direction as the sediments coming out of Panther Creek is pushed downstream by the current of Spring Creek before they are deposited in the delta bar. Look at the delta deposits in the satellite images and the pictures above and compare them to the deposits you are seeing during your visit.
In the shallow portions of Panther Creek ripples are forming and migrating along the bottom of the creek. If you get in the creek and watch a single ripple for a minute or two, you can see sand grains bouncing along moving up the stoss (upcurrent) side of the ripple and then deposit on the lee (down current) side of the ripple. The whole ripple will move down the stream in this fashion. As you observe this process think about how a ripple feature can form a layer and why typically only the lee side of a ripple is preserved.

Scraping at a bank can reveal the range of grain size that the creek can transport as well as various sedimentary structures including layering, ripples and crossbedding in the creek deposits.
Stop 2 – Meander Bends along Panther Creek

Directions – From Stop 1 return to the road along the same path that you took to get there. At the road turn left and continue ~20 yards and enter the Circle path on the left. Go down the Circle path until the path splits. At the split go down the left hand path and follow it to Panther Creek. Alternatively, walk up the creek along the bank if it is clear of vegetation or in the channel itself.

Panther Creek has a number of meanders along its length. At this stop, observations can be made of the many morphological features of a meandering stream including cutbanks, point bars, pools, runs and riffles. The sharp bend in the creek at Meander 3 typically has a log jam.
Scraping at a bank can reveal the range of grain size that the creek can move as well as various sedimentary structures including layering, ripples and crossbedding.

Recent erosion of a cutbank on the outer bend of a meander has caused the trees at the top of the cutbank to fall over into the creek.
From satellite images taken at different dates over these meander bends, changes through time can be observed. What differences in bar forms, cut banks and channel paths can you observe? The creek will also be different from the satellite images and pictures during your visit.
This satellite image shows the creek at bankful stage. Notice on the cutbank of the top meander the trees that have fallen over across the creek caused by erosion from this flooding event (the same trees and cutbank can be see in an previous image).
Stop 3 – Bridge over Panther Creek

**Directions** – From Stop 2 return to the Circle path along the same path that you took to get there. At the Circle path go the left and continue on the Circle path until in comes back to the gravel road. At the road turn left and continue along until you reach the bridge crossing over Panther Creek.

The previous stops have looked at the morphology of a stream under natural conditions. At Stop 3 a bridge has been built across the creek and has modified the natural process. Take a look around and see how the stream has changed because of the bridge from what we have observed at the previous two stops. How has the stream interacted with the man-made structure of the bridge? What parts of stream morphology can you identify here?
References for Material Used


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http://www.sd13.org/teachers/dirving/


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http://www.geol.umd.edu/~piccoli/100/CH12.htm


http://w3.salemstate.edu/~lhanson/gls210/gls210_streams2.htm

http://www.geologycafe.com/class/chapter9.html
Label the features of a meandering stream that can be seen on a section of Spring Creek.

1) Cut bank  
2) Point bar  
3) Thalweg  
4) Right bank  
5) Left Bank  
6) Riffle  
7) Pool
Exercise 2

Sketch and label the sedimentary structures found when a section of a bar is scraped clean. Include a scale bar.

1) Layering
2) Ripple features
Exercise 3 – Stop 2

In a cross-section across the stream where do you think will be the coarsest grains?

In a cross-section across the stream where do you think will be the finest grains?

Describe the location of the sample point (bar, thalweg, right bank, left bank, pool, riffle)
Describe the sediment at the sample point (grain size, roundness, sorting, color, composition)

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<th>Sample</th>
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At Stop 2, locate these points on one of the cross sections from one side of the stream to the other to use for your sediment sample descriptions. The creek will be different from the satellite image so just do your best to find locations that cover different features of the stream.